EPA Comments on CPG Modeling Approach – 4/9/14

Based on files transferred in December 2013 and CPG presentations

EPA recognizes that the CPG modeling is still a work in progress; however, several issues related to the analyses presented to EPA are described below. Modification of the CPG modeling approach is necessary to address these issues.

Contaminant Fate and Transport Simulation Sequence

Model input and output files provided by the CPG indicate the following components of the contaminant fate and transport (CFT) simulation of water column and bed contaminant concentrations for the period beginning in 1995 and continuing into future:

- Simulation of the period October 1, 1995 through September 30, 2009 (water years 1996-2009), using bed mapping developed with 1995 data in the RM1-7 reach and more recent data upstream of RM7 and downstream RM1,
- Restart of the model with re-initialized bed contaminant concentrations (based on bed mapping of 2008-2012 data) and simulation of the period October 1, 2009 through September 30, 2012, (water years 2010 – 2012) and
- Projection simulations for remedial alternatives (including MNR) beginning October 1, 2012.

Bioaccumulation model input and output files (and discussions with the CPG's modelers) indicate that a steady-state calibration was performed with average exposure concentrations generated in the water year 2010-2012 CFT model simulation. Benthic organisms are exposed to particulate phase contaminants computed in the lowest layer of the water column and the only portion of the food web exposed directly to bed contaminants are certain fish species, for which a small fraction (5-15%) of their diets comes from sediment particles in the top two cm of the bed.

EPA noted concerns about this feeding structure during the February 13, 2014 modeling web-meeting. Additional comments on the feeding structure will be provided separately. The comments below address how subdividing the 1995 - 2012 CFT simulation into two parts introduces discontinuities in contaminant concentrations in the bed, and vertical profiles of concentrations in the top 15 cm. This has a substantial effect on the bioaccumulation calculations, given that they include both steady state and dynamic components.

The CFT simulation begins in October 1995 with vertically uniform concentrations in the top 15 cm of the bed (Figure 1). During the water year 1996-2009 period, vertical gradients develop between the water column, surface sediments (top 2 cm), and top 15 cm concentrations as a result of the parameterization of the bed processes and bed-water column exchange in the model. The re-initialization of bed concentrations in October 2009 (based on mapping with 2008 – 2012 data)

eliminates the vertical gradients in the top 15 cm of the bed, and results in an instantaneous increase in contaminant concentrations in both the top 2 cm and 15 cm of the bed. The vertical concentration gradients in the top 15 cm of the bed begin to reestablish as the simulation progresses from water year 2010 into the post-2012 projection period, resulting in a decline in concentrations in the top 2 cm.

The problem lies in the use of the post 2009 results for comparison to water column and sediment data, and use of the water year 2010 – 2012 CFT results as exposure concentrations in the steady-state bioaccumulation calibration. The limited time for reestablishment of vertical gradients in the surface sediments results in elevated water column and top-2 cm bed concentrations during this period and an artificial decline in those concentrations projected into the future associated with re-establishing the vertical gradients. As a result, the time period with water column contaminant concentration data, supplemental low resolution sampling (sediment contaminant data) and the period used for the steady-state bioaccumulation calibration represents a period when the model results reflect a significant transient associated with the re-initialization of bed contaminant concentrations in October 2009, and are atypical compared to the remainder of the 1995 – 2057 simulation period (Figure 2). In addition, the period used for the steady state bioaccumulation calibration includes the period of Hurricane Irene, further adding to the atypical nature of this period.

Under both the long term calibration and projected conditions the 2 cm concentration is approximately 30% (or less) of the 15 cm, but under the short term calibration condition the 2 cm concentration is approximately 80% of the 15 cm average. Table 1 presents a summary of water column and bed concentrations from three time periods in the MNR simulation: end of the 1995-2009 simulation (before bed concentration reset) average of water years 2010-2012, and 2057, at the end of the projection simulation. This comparison shows how atypical the water year 2010-2012 period is compared to the longer-term simulation periods in terms of water column and bed 2,3,7,8 TCDD concentrations. The ability of the steady-state bioaccumulation model calibration to reproduce biota tissue concentrations does not translate into confidence in predicted future biota concentrations, given the significant discontinuity and transient present in the CFT results used as exposure concentrations in the steady-state calibration.

The CPG modeling approach needs to be revised to:

- eliminate the effect of the transients and discontinuities in the 1995 – 2012 simulation (e.g. introduce a spin-up to a continuous time variable simulation)
- present model-data comparisons for CFT and bioaccumulation simulations for 1995 – 2012
- eliminate use of the period containing Hurricane Irene from the bioaccumulation steady state calibration

Table 1. Comparison of Water Column and Bed Parameters from points in MNR Simulations

		Average values for three time periods in three reaches		
Parameter	**Reach**	**2009**	**2010-2012**	**2057**
Water Column TCDD (pg/L)	RM0-8	1.9	16.5	2.9
	RM8-17	1.3	9.0	3.2
	RM0-17	1.7	14.2	3.0
Water Column TCDD (ng/Kg-DW or ppt)	RM0-8	89.6	1327.1	145.5
	RM8-17	21.1	180.9	77.8
	RM0-17	69.2	985.6	125.3
Sediment Top 2cm TCDD (ng/Kg-DW or ppt)	RM0-8	162.8	722.0	105.7
	RM8-17	114.4	553.7	108.2
	RM0-17	145.9	663.3	106.6
Sediment Top 15cm TCDD (ng/Kg-DW or ppt)	RM0-8	360.9	780.0	321.3
	RM8-17	686.9	845.9	727.9
	RM0-17	473.7	802.9	462.6
Ratio: top 2 to top 15 cm TCDD (ng/Kg-DW or ppt)	RM0-8	45%	93%	33%
	RM8-17	17%	65%	15%
	RM0-17	31%	83%	23%

Relationship between water column and bed concentrations

Based on Anchor-QEA's evaluation of water column and bed contaminant concentrations, they concluded that water column contaminant concentrations are approximately 20% of the bed concentration. This conclusion is based on averages in the water column and sediment concentrations after "outliers" were removed and data were binned spatially around the water column sampling locations. It is not clear how this conclusion factors into the ongoing modeling, however, EPA has concerns about this analysis and how it was used in the modeling previously presented by the CPG and incorporated in the targeted remedy modeling.

This empirical relationship does not hold throughout the model domain as it was applied in the targeted remedy model, and would not hold under a condition where the bed has been replaced with clean non-cohesive material.

The individual water column data, without averaging or excluding points (Figure 3), fall well within the range of the underlying sediment concentrations. Without binning and averaging both the sediment and water, there is a great deal of overlap of the two datasets.

The CPG must describe if and how the relationship described by Anchor-QEA will be used in ongoing modeling.

CPG Consolidation Approach

The CPG's modeling team has discussed plans to improve on the approximations used to pass bed bulk density results from one model to the next. One proposed solution to address consistent bed elevation changes across models could result in the loss of the conservation of mass of solids as well as concentration issues. EPA encourages the modeling teams to continue to work towards improving the model, with the goal of avoiding the introduction of problems, such mass balance issues, as part of an effort to improve other model approximations.

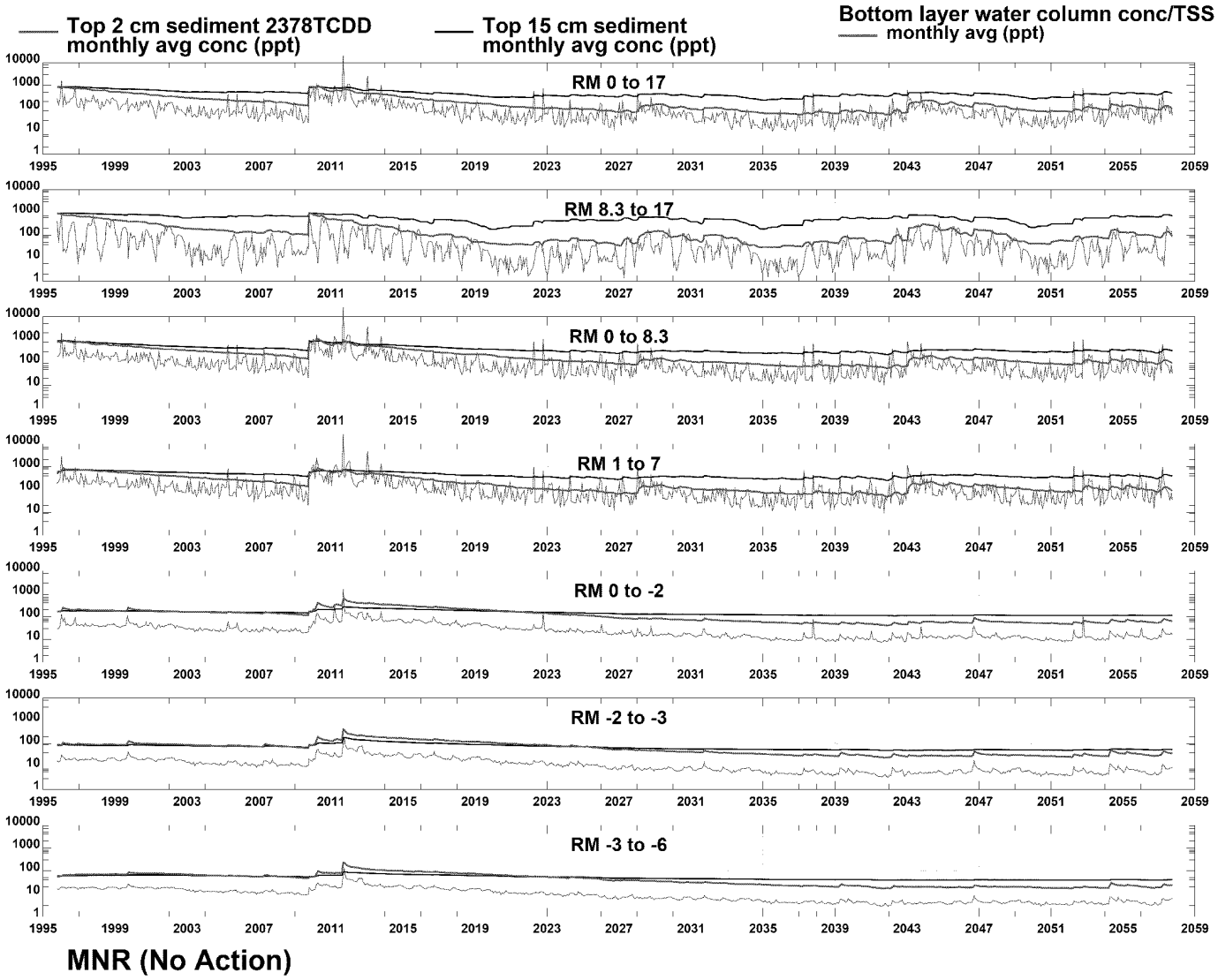

Figure 1. Time series of 2,3,7,8 TCDD concentrations computed for water column bottom layer, top 2 cm and top 15 cm of bed

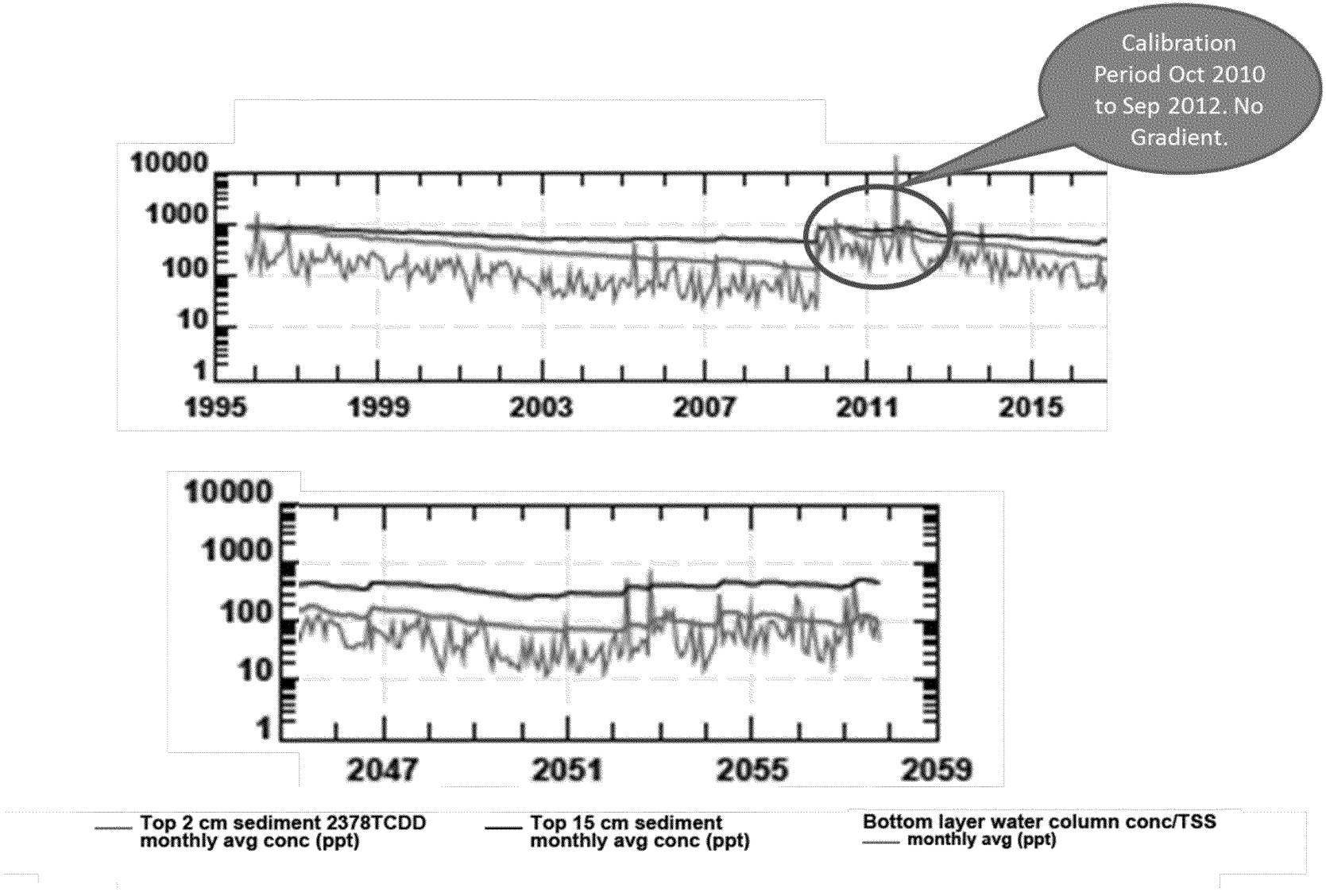

Figure 2. Expanded view of water column and bed 2,3,7,8 TCDD results for 1995-2009, 2009-2012, and 2045-2057 periods of MNR simulation

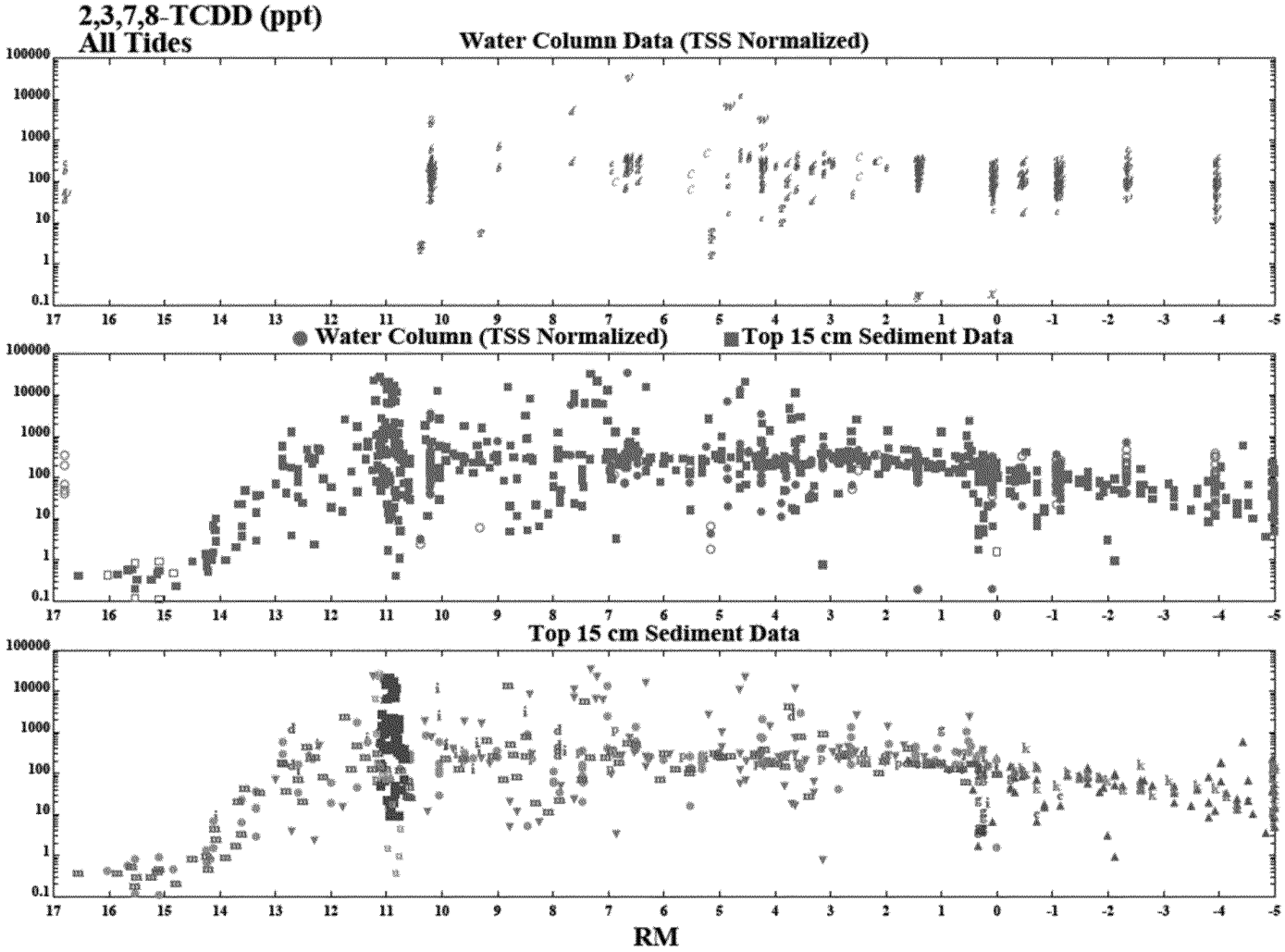

Figure 3. Comparison of 2,3,7,8 TCDD water column and sediment data (see Table 2 for key to datasets)

Table 2. Key to data sets shown on Figure 3

Sediment Datasets

- ● Data used for ICs
- A 1990 Surficial Sediment Investigation
- B EPA EMAP 90-92
- C 1991 Core Sediment Investigation
- D NOAA NS&T Hudson-Raritan Phase I, 1991
- E 1992 Core Sediment Investigation
- F 1993 Core Sediment Investigation - 01 (March)
- G 1993 Core Sediment Investigation - 02 (July)
- H 1993 USEPA Surficial Sediment Program
- I NOAA NS&T Hudson-Raritan Phase II, 1993
- J REMAP, 1993
- K 1994 Surficial Sediment Investigation
- L REMAP, 1994
- M 1995 RI Sampling Program
- N 1995 Sediment Grab Sampling Program
- O 1995 USACE Minish Park Investigation
- P 1996 Newark Bay Reach A Sediment Sampling Program
- Q 1997 Newark Bay Reach B,C,D Sampling Program
- S 1998 Newark Bay Elizabeth Channel Sampling Program
- T REMAP, 1998
- U 1999 Late Summer/Early Fall ESP Sampling Program
- X 1999 Prelim Toxicity Identification Eval
- Y 1999/2000 Minish Park Monitoring Program
- a 2000 Spring ESP Sampling Program
- b 2000 Toxicity Identification Evaluation
- c 2005 MPI - Newark Bay Phase I Oversight
- ▲ 2005 Newark Bay RIWP Phase I Sediment Investigation
- d 2005 USEPA-MPI High Res Sediment Core
- e 2006 HRSA RI Sampling Program
- g 1999-2006 Honeywell Intl Sampling
- i 2007 USEPA-MPI-EMBM Sediment Samples
- j 2007 USEPA-MPI Dundee High Res Core
- k 2007 Newark Bay Phase II TSI Sediment Samples
- ◉ 2008 CPG Low Resolution Sediment Coring
- m 2009 CPG Benthic Sediment Study
- o 2009 USEPA-MPI Benthic Oversight
- p 2010 CPG Benthic Sediment Sampling
- q 2010 USEPA-CDM Benthic Oversight
- ■ 2011 CPG River Mile 10.9 Data
- r 2012 CDMSmith Background BenthicSediment
- s 2012 CDMSmith LowRes Coring Supplemental
- t 2012 CPG Background Benthic Sediment
- ▼ 2012 CPG Low Res Coring Supplemental
- u 2012 CPG River Mile 10.9 Data

Water Column Datasets

- 𝒜 1993-1997 USACE - DMDAT
- 𝒷 1995-96 Passaic Study RI/FS Sed Mobility
- 𝒸 1997 Outfall Sampling Program
- 𝒹 1998-2001 CARP Database
- 𝓔 1999 Newark Bay Reach A Monitoring
- 𝒻 1999 NewarkBay ReachABCDBaselineSampling
- 𝒢 1999 USACE Drift Removal Monitoring
- 𝒽 1999-2006 Honeywell Intl Sampling
- 𝒾 2000 Toxicity Identification Evaluation
- 𝒿 2005 Hydrodynamic Mooring
- 𝒦 2005 MPI SPMD Deployment
- 𝓛 2005 USEPA-MPI High Flow Water Column
- 𝓂 2005 USEPA-MPI Large Volume Study
- 𝒩 2005 USEPA-MPI Small Volume Water Column
- 𝒪 2005 USEPA-MPI Water Column Above RM 8.5
- 𝓅 2007 USEPA-MPI-EMBM Water Column Sample
- 𝒬 2009 CPG LPR Water Column Monitoring DEC
- ℛ 2010 CPG LPR-NB PWCM Field Measurements
- 𝓈 2010 CPG LPR-NB PWCM Sample Dataset
- 𝒯 2010 USEPA LBG-CDM PWCM Oversight
- 𝓊 2011 CDM Smith CWCM Sampling Data
- 𝓋 2011 CPG CWCM Sampling Data
- 𝓌 2012 CDM Smith CWCM Sampling - Round 2
- 𝒳 2012 CDM Smith CWCM Sampling - Round 3
- 𝒴 2012 CDM Smith CWCM Sampling - Round 4
- 𝓏 2012 CDM Smith CWCM Sampling - Round 5
- 𝒶 2012 CDM Smith CWCM Sampling Round - 6
- 𝒷 2012 CPG CWCM Sampling - Low Flow
- 𝒸 2012 CPG CWCM Sampling - Round 2
- 𝒹 2012 CPG CWCM Sampling - Round 3
- 𝓮 2012 CPG CWCM Sampling - Round 4